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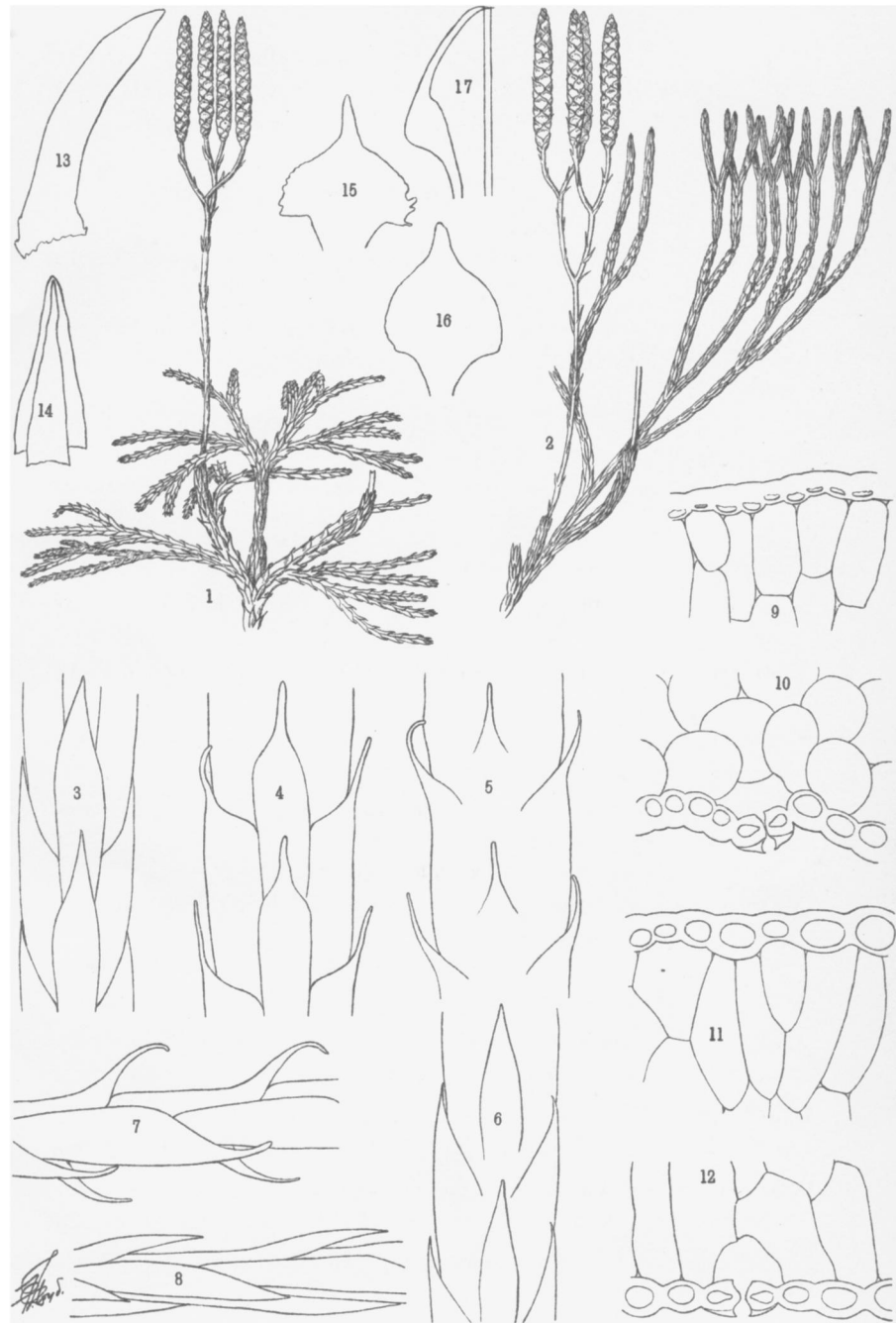
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LLOYD ON LYCOPODIUM.

BULLETIN
OF THE
TORREY BOTANICAL CLUB

NOVEMBER 1899

Two hitherto confused Species of *Lycopodium*

BY FRANCIS E. LLOYD

[PLATE 370]

While botanizing during the past summer in southern Vermont in company with Dr. Marshall A. Howe, it was our fortune to come across, in an open sloping pasture, an extensive growth of a *Lycopodium*, which heretofore has been, in this country, referred to the variety *chamaecyparissus* of *L. complanatum*. Associated with it, and also growing in abundance was *L. complanatum*, and the very great difference in the appearance of the two plants, both as to color and habit, at once attracted our attention. Further field observation revealed the fact that the so-called variety differed from *L. complanatum* in several important details both morphological and physiological, the position of the rhizome among others. In *L. complanatum* this runs along the surface of the ground and is flattened above, develops chlorophyll in response to its exposed position, and has narrow leaves which curve upwards, while the rhizome of *L. chamaecyparissus* is strictly underground, buried to a depth of 2-4 centimeters, a fact which Dr. Howe and I sufficiently verified by digging up the new rhizomatous growths out of the tough sod at the periphery of the area covered by the colony, and which I have myself verified in many individuals subsequently found near Cold Spring, Long Island. The rhizome of this plant is, moreover, supplied with lanceolate to ovate leaves which are contracted at the base, and is white, except when, as is sometimes the case, the plant is forced out of its normal direction by hard

obstacles, thus becoming exposed to the light. This difference of habit in respect to position was also recorded by C. F. Austin in a note in his writing attached to the sheet upon which is mounted a specimen of *L. chamaecyparissus* collected by him in Bergen county, New Jersey.

Another very pronounced and quite constant difference is the habit, on the part of *L. chamaecyparissus*, of producing annual growths at the ends of the branchlets. These new growths are more or less orthotropic, according as the habitat is exposed or shaded, and usually make angles with the earlier growth. This is especially noticeable as the aërial stems of the plant are frequently long and weak, allowing the weight of the foliage, which is often great, to force them out of their original vertical position, to make angles with the previous years' growths. There is thus produced a curious and distinctive habit which is in marked contrast with that of *L. complanatum* in which the branchlets are plagiotropic, and do not produce annual innovations except very occasionally, and then only short imperfect growths, which cannot at all be compared with the vigorous unfailing annual growth of *L. chamaecyparissus*.

Correlated with the more vertical habit of *L. chamaecyparissus* is the less pronounced dorsiventral character of the more distal branches and the similarity in form of their leaves. Here the leaves of the morphological under side of the branches are scarcely different in their amount of development from those of the upper side, while in *L. complanatum* they are so reduced that only their apices, abruptly spreading from the concave lower side of the branchlet, remain in evidence. This spreading character is common to all the leaves of *L. complanatum* while in *L. chamaecyparissus* the apices of the leaves of the lateral and under rows are appressed, so much so that those of the leaves of the lateral rows curve in underneath the flattened lower side of the branchlet.

In addition to these external leaf characters is to be added the glaucous character of *L. chamaecyparissus*, as compared with the absence of this character in *L. complanatum*. I have noticed that specimens of the former plant keep their moisture some time longer than do specimens of the latter, though I cannot give precise data on this point.

Nor are the differences wholly confined to the external and

therefore more readily observable features, for an examination of transverse sections of the branchlets shows that the parenchyma beneath the lower epidermis is made up in *L. chamaecyparissus* of elongated cells of columnar form with oblique ends, similar but a little broader than those beneath the upper epidermis. This similarity in tissue is carried also into the epidermis, the cells of which, both on the upper and lower sides are nearly of the same size and have lumina of equal proportions. In *L. complanatum*, however, the parenchyma of the lower part of the branchlet is made up of globular cells, while those above are columnar. Here, too, we find that the cells of the upper epidermis have lumina much more reduced than do those of the lower. (Pl. 370, figs. 9, 10, 11 and 12.) The sclerenchyma sheath is also more strongly developed in *L. chamaecyparissus*.

Furthermore, there is a disparity in the time at which the spores ripen, a fact also not unnoticed by Austin, who records that in Bergen county, New Jersey, the spores of *L. chamaecyparissus* ripen "from one to two months earlier than in the type" that is, *L. complanatum*. Even in Vermont, where such phenomena are compassed in a shorter time, and where these observations were made, there is a difference of at least three weeks to a month in the time of spore-ripening. This fact must be one of considerable importance.

In the light of the above facts it seems strange that these two plants have been regarded by several botanists as not deserving of separate specific rank, though it is interesting to know that the veteran Alexander Braun so regarded them and that Dillenius* fully appreciated their differences, as is evidenced by his excellent figures. It appears from descriptions and specimens that the two plants are found abundantly in Europe and have been repeatedly observed growing together. In this connection Luerksen† observes: "The two plants (*i. e.*, *L. complanatum* and var. β *chamaecyparissus*) in these extreme forms appear so different, that they might well be regarded as distinct species. They pass, gradually, however, through intermediate forms, from one to the other." This experience seems, however, not to be dupli-

* Hist. Musc. pl. 59 (*L. complanatum*) and 60 (*L. chamaecyparissus*). 1741.

† Rabenhorst, Kryptogamen-Flora. Farnpflanzen, 1: 825.

cated on this side of the Atlantic, for a careful search over an acre of ground in which a large number of colonies of both species were growing together, often intermixing, failed to discover anything at all to support this view. The two plants, growing on the same spot with their rhizomes crossing, were completely distinct. It would be of value if the botanists of this country to whom the opportunity may come, would make observations bearing on this matter. It may be added that certain European botanists appear to entertain no doubt as to the specific distinction of the two plants.

The attempt was made by the writer to find what differences, if any, existed between the spores, but without any very positive results. The spores of European specimens as well as from the United States were examined, and as much variation appears to exist between individual spores of *L. complanatum*, as between the spores of *L. clavatum* and either of these here under consideration. On the whole, however, there is a larger unreticulated area on the inside facets of the spores of *L. chamaecyparissus*, while the angles of the reticulations appear to be thickened in *L. complanatum*. I have not, however, been able to apply these criteria with unfailing certainty, so that I hesitate to assert that any value should be attached to them. There are slight differences, also, in the shape of the sporophylls, which in *L. chamaecyparissus* are usually more abruptly contracted beneath the apex than in *L. complanatum*.

LYCOPODIUM CHAMAECYPARISSUS A. Br.

Rhizomes extensively creeping 2–4 cm. below the surface of the ground, occasionally forced by obstructions to grow upward, but turning down again when the obstruction is passed, in color white, terete, sparingly branched in the horizontal plane, their whorled or loosely spirally arranged leaves lanceolate or ovate to broadly ovate (1–2 mm. broad), usually the latter, and then scarious; abruptly contracted into a narrow base, acute, their margins membranous and erose; the primary aerial shoots weak, terete, usually sinuously bent and often becoming decumbent under the weight of the superadded foliage, the axis repeatedly forking until it forms a mass of more or less vertically placed somewhat flattened branchlets which are plano-convex in transverse section, 1.5–2 mm. broad (concave beneath on drying); the terminal branchlets regu-

larly producing more or less orthotropic innovations the second and sometimes the third season, the lower and therefore older foliage branches ultimately spreading and becoming lax, some of the medially placed branches remaining short, thicker, terete, strictly vertical, and producing either additional foliage parts or ultimately running up into strobile-bearing peduncles: leaves of the primary aerial axis in 6-8 rows, those at the base of the shoot similar to those of the rhizome, appressed, passing higher up the axis from ovate through lanceolate-acute into the acuminate form; those of the subterminal and terminal branchlets in four rows, an upper, an under and two lateral, glaucous, bluish green, acuminate, appressed, those of the under row differing scarcely at all from those of the other three rows, the leaves of the lateral rows somewhat incurved underneath, all becoming shorter and more crowded towards the end of the season's growth: peduncles terete, glaucous, 50-60 mm. long to the first forking, usually twice forked, the second 8-18 mm. distant from the first, spreading and curving upward, the leaves on the peduncle and its branches spirally scattered or less commonly loosely segregated into whorls of threes, spreading-acuminate, scarious-tipped; strobiles, two, three or usually four, 20-28 mm. long, the sporophylls broadly depressed ovate, truncate at the base, the lateral margins variously toothed, suddenly contracted into a subulate scarious tip; sporangium reniform, opening by a transverse slit along the top; spores deep yellow in mass, regularly areolate on the convex face, the areolae on the triangular inner faces becoming larger, more irregular and fading away so as to leave a triangular smooth area in the internal angle, ripening early in August. (*f.* 2, 3, 6, 8, 11, 12, 16, 17.)

The aerial parts reach a maximum height of about 22 cm. exclusive of the spore-bearing parts which project an additional height of 5-7 cm. above the general level of the foliage. The color is light bluish green, and glaucous throughout except on the aged lower branches, from which the waxy layer is worn away.

Found by Dr. M. A. Howe and myself growing on a sunny slope, where the plants made very dense masses of foliage with vertically placed branchlets. Newfane, Vt., July-August, 1899. Specimens found later (Oct. 14, 1899) by myself, on the hills near Cold Spring Harbor, Long Island, N. Y., which were growing in the shade, and which were very much less vigorous than the Vermont material, have looser foliage, the branchlets of which do not stand vertically, though they do turn upward at the ends, and the

innovations grow upward. The variation in position may be regarded as a response to different light influences. This series also includes a single weak plant with widely spreading leaves, curiously mimicking a seedling of *Juniperus Virginiana*. The above material is all in the herbarium of the New York Botanical Garden.

Other herbarium material has been examined as follows :*

CONNECTICUT: New Haven, 1858, *D. C. Eaton* (G.).

DELAWARE: near Iron Hill, Aug. 21, 1894, *A. Commons and E. Tatnall* (C.). Latrobe Canal feeder, 2 miles west of Iron Hill, Aug. 5, 1895, *A. Commons* (G.).

DISTRICT OF COLUMBIA, July, 1879, *L. F. Ward* (N.).

GEORGIA: Tallulah Falls, Apr. 19, 1891, *L. M. Underwood*, no. 2550a (U.).

MAINE: Mt. Desert, Sept. 5, 1891, *T. G. White* (C.). Mt. Desert Island, July 9, 1890, *John H. Redfield* (U.). Aroostook Co., St. Francis, dry woods, Aug. 9, 1895, *M. L. Fernald*, no. 217 (C. N. G. U.). Orono, "dry woods," Oct. 13, 1890, *M. L. Fernald* (G.).

MARYLAND: Bladensburg, July 20, 1879, *L. F. Ward* (U.); 1880, *L. F. Ward* (N.).

MASSACHUSETTS: Essex Co., *Oaks* (C.).

MICHIGAN: Near Alpena, July 11, 1895, *C. F. Wheeler* (G. N. C.). Sand dunes, Lake Huron, Huron Co., Aug. 5, 1896, *Charles A. Davis* (N.). Keweenaw Co., *Robbins* (G.). Keweenaw Co., "woods and fields," Aug., 1890, Sept., 1889, *O. A. Farwell*, no. 746 (G.).

MINNESOTA: Lake Kilpatrick, Caseo Co., July, 1893, *C. A. Ballard* (N.).

NEW HAMPSHIRE: "old clearings," Jaffrey, July 15, 1897, *B. L. Robinson* no. 225 (G.).

NEW JERSEY: Bergen Co., *C. F. Austin* "stems running rather deep (2-4 inches) in the ground. Of a more slender habit and generally with more numerous spikes than the typical form from which it is readily distinguished when they grow side by side by its shedding its spores 1-2 months earlier (in Aug.) and by its spikes turning saffron yellow. I have never found it except in shady places" (G.).

* The letters C, G, N, U and Y indicate the Columbia, Gray, National, Underwood and New York Botanical Garden herbaria, where the cited specimens may be consulted.

NORTH CAROLINA: mountains, Waynesville, Sept. 1896, *S. M. Huger* (C.).

PENNSYLVANIA: Tobyhanna, Pocono Mt., Aug. 20, 1887, *N. L. Britton*. (C.).

VIRGINIA: Clifton, Oct. 12, 1884, *L. F. Ward* (U.).

LYCOPODIUM COMPLANATUM L.

Rhizomes extensively creeping along the surface of the ground, exposed or in moss, etc., usually green, flattened above, furrowed on the flattened surface, sparingly branching in the horizontal plane, spirally arranged or sometimes loosely segregated in whorls: their leaves lanceolate, acuminate, scarious-tipped, the lateral ones curving upward; primary aerial shoots strong, flattened and furrowed on one side, the branches convex on the upper side, concave below (1.8–2.5 mm. broad), spreading out into a horizontal plane, the medially placed branches more nearly terete, and either producing additional foliage-bearing shoots or, ultimately, sporangium-bearing peduncles: leaves of the vertical axes spirally placed or in loose whorls, spreading, acuminate, scarious-tipped, the several (5–8) rows being reduced to four on the foliage branches; the leaves of the upper and lateral rows, which are separated as by a continuous furrow, cuspidate, with spreading apices, bright green, those of the under row reduced to slender, curved, spreading, cuspidate apices, the under side of the branchlets thus appearing devoid of foliage, lighter in color and concave; all the leaves decreasing gradually in size from the base to the tips of the branches: peduncles (5–7.5 cm. long up to the forking) terete, a little stouter than in *L. chamaecyparissus*, furrowed, forking usually twice, the first and second forks 2–5 mm. distant from each other: pedicels straight, 5–8 mm. (mostly 7–8 mm. long), bearing strobiles 15–25 mm. long: leaves of the peduncles and pedicels scattered or loosely whorled in threes, acuminate, scarious-tipped, spreading: sporophylls broadly ovate, more or less toothed on the lateral margins, contracted gradually into a scarious apex: sporangia reniform, opening by a transverse slit: spores reticulate on the four faces, ripening late in August and in September. (*f.* 1, 4, 5, 7, 9, 10, 13, 14, 15.)

CONNECTICUT: West Goshen, Aug., 1889, *L. M. Underwood* (C. U.). Greens Farms, Aug. 25, 1894, *C. L. Pollard*, no. 233. An abnormal condition with asporogenous spikes (N.). Derby, July 7, 1895. "Dry woods, common," *E. H. Eames*, *M.D.* (N.).

DISTRICT OF COLUMBIA: Near the Sligo, north of Takoma, July 10, 1895, *C. L. Pollard*, no. 467 (N.).

INDIANA: Fern, Putnam Co., Oct., 1892, *L. M. Underwood* (U.).

MAINE: Anson, July 9, 1885, *T. F. Collins*, "Fertile" (G.).

MASSACHUSETTS: Essex Co., *William Oakes* (C.). Mt. Toby, near Amherst, July 27, 1895, *Mrs. A. F. Stevens* (N.); 1871, *Dr. Palmer* (N.). Benjamin Hill, near Winchendon, Worcester Co., Sept. 3, 1895, *C. L. Pollard* (N.). Concord, "woods around Walden Pond," Sept. 30, 1879, *W. P. Rich* (G.). Concord, Nov. 1, 1890, *L. M. Underwood* (U.). A form with six strobiles on the peduncle and more distant forkings, Northfield, July 5, 1890, *F. E. Lloyd* (Y.). Williamstown, Oct., 1891, *F. E. Lloyd* (Y.).

MARYLAND: near Signal Tree Heights, between Washington and Silver Spring roads, Oct. 7, 1893, *Adam Steitz* (N.). Spencerville, July, 1891, *J. M. Holzinger* (N.).

MINNESOTA: Soudan, St. Louis Co., 1896, *J. H. Ely* (C.). Duluth, July 26, 1889, pine woods, 16 miles west of Duluth (N.).

NEW HAMPSHIRE: southern "woods common," July 9, 1897, *B. L. Robinson*, no. 187 (G.). Seabrook, 1894, *Alvah Eaton* (with abnormal forking spikes) (U.). Benton, July 4, 1890, *S. F. Tower*.

NEW JERSEY: Clifton, Sept. 23, 1894, *T. H. Kearney, Jr.* (C.). Bergen Co., "matures its spores in September and October," *C. F. Austin* (C.). Bergen Co., "a variety with short rigid leaf-branches and numerous short spikes," *C. F. Austin* (C.). Stockholm, "swamp, 1100 ft. alt.," Aug. 1-15, 1895, *Wm. M. Van Sickle* (N.).

NEW YORK: Tannersville, Greene Co., Oct. 6, 1891, *A. M. Vail* (C.). "Dry copse, near woodland, common," Nov. 28, 1890, *R. Kenyon* (N.). Cold Spring Station, Long Island, in deep woods, Oct. 14, 1899, no spikes found, *F. E. Lloyd* (Y.). Morrisville, Oct., 1878, *L. M. Underwood* (U.). West Camden, 1897, *Arma A. Smith* (U.).

ONTARIO: Gun Flint Lake, July 18, 1891, *F. F. Wood* (N.).

PRINCE EDWARD ISLAND: Cantire, Sept. 3, 1883, *John Macoun* (C.).

QUEBEC: Notre Dame du Lac, Termiscouata Co., Aug. 2, 1887, *John I. Northrop* (C.).

VERMONT: Willoughby Lake, Aug. 22, 1895, *Mrs. G. F. Stevens* (N.); Willoughby, July 26, 1892, *H. H. Rusby* (C.); Newfane, July-Aug., 1899, *M. A. Howe* and *F. E. Lloyd* (Y.).

WEST VIRGINIA: South Fork of Holston River, Smyth Co.,
June 15, 1892, *N. L. and E. G. Britton and A. M. Vail* (C.).

Explanation of Plate 370

The figures were drawn from specimens collected near Newfane, Vt., growing in the same habitat. Figures 3-8 were drawn to the same scale $\times 9$, as were also figures 9-12 and 13-17.

FIG. 1. *Lycopodium complanatum*; upper part of aerial shoot bearing two peduncles, only one of which is shown. $\times \frac{2}{3}$.

FIG. 2. *Lycopodium chamaecyparissus*; upper part of aerial shoot. In this particular plant the peduncle does not extend as far as it does normally above the general level of the foliage. The terminal branchlets can be seen to make definite angles with the subterminal, previous year's growth. $\times \frac{2}{3}$.

FIGS. 3, 6, 8. Upper, under and lateral views respectively, of a part of a branchlet of *Lycopodium chamaecyparissus*.

FIGS. 4, 5 and 7. Upper, under and lateral views respectively, of a part of a branchlet of *Lycopodium complanatum*.

FIGS. 9 and 10. Portions of the epidermis and subjacent parenchyma from the upper and under sides respectively, of a branchlet of *Lycopodium complanatum*.

FIGS. 11 and 12. The same of *Lycopodium chamaecyparissus*.

FIGS. 13 and 14. Outlines of scales from the rhizome of *Lycopodium complanatum*.

FIG. 15. Sporophyll of *Lycopodium complanatum*.

FIG. 16. Sporophyll of *Lycopodium chamaecyparissus*.

FIG. 17. Half-outlines of scales from the rhizome of *Lycopodium chamaecyparissus*.